

# Extreme Environment Solar Power (EESP)

Completed Technology Project (2015 - 2020)

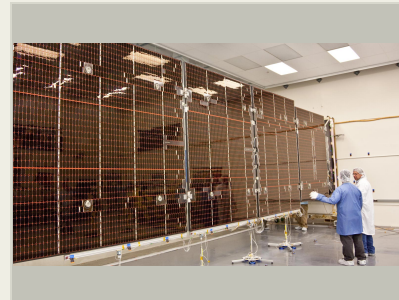


## Project Introduction

The Extreme Environments Solar Power (EESP) Project is developing advanced photovoltaic technologies to provide reliable power for NASA missions in the general vicinity of Jupiter. These advanced concepts, which address radiation damage and Low sunlight Intensity, Low Temperature (LILT) degradation effects, will extend NASA's use of solar array technology for exploration of the depths of our solar system. The majority of NASA missions utilize solar cells that are designed and qualified for long-term operation within an Earth-orbit environment. Deep space NASA missions, however, subject solar-powered arrays to stresses well beyond those experienced by commercial space and military satellites. Spacecraft sent to explore planets and other bodies farther from the Sun will encounter reduced light intensity levels and very low temperatures. A subset of these missions may encounter low-intensity low temperature (LILT) environments that can cause performance degradation in the power output of the solar cell. This LILT effect has been noted and verified through ground-based testing. The effect is variable from cell to cell, affecting the reliability of accurately predicting solar array performance throughout the life of a mission. The issue becomes more pronounced when one cell with this degradation characteristic is added in a series string with well behaved, predictable cells. Under LILT conditions, the entire string will be current-limited by the output of the bad cell and the performance of the entire string will be degraded. Current methods of minimizing LILT effects involve screening all solar cells for the mission, adding considerable cost and schedule to the spacecraft power system.

## Anticipated Benefits

Enable subset of future NASA missions at larger distances from the sun using solar power systems  
Enable longer-duration missions using solar power in higher radiation Earth orbits  
Increase mission life, capability, and/or decrease mission mass/cost for these missions



Technicians test the deployment of a massive solar array that will power future NASA spacecraft.

## Table of Contents

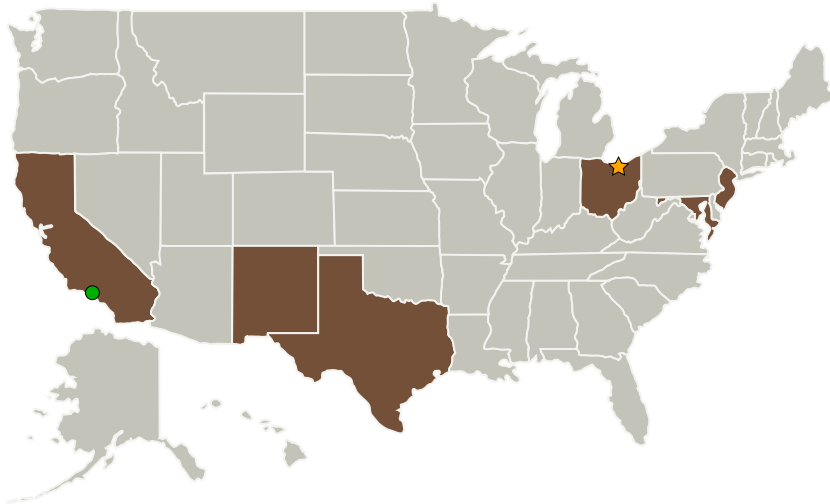
Project Introduction	1
Anticipated Benefits	1
Primary U.S. Work Locations and Key Partners	2
Organizational Responsibility	2
Project Management	2
Technology Maturity (TRL)	2
Project Transitions	3
Images	3
Project Website:	3
Technology Areas	3
Target Destinations	3

## Extreme Environment Solar Power (EESP)

Completed Technology Project (2015 - 2020)



## Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★ Glenn Research Center(GRC)	Lead Organization	NASA Center	Cleveland, Ohio
● Jet Propulsion Laboratory(JPL)	Supporting Organization	NASA Center	Pasadena, California
The Boeing Company(Boeing)	Supporting Organization	Industry	Chicago, Illinois

Co-Funding Partners	Type	Location
Planetary Science	NASA Program	
SBIR/STTR	NASA Program	

## Primary U.S. Work Locations

California	Maryland
------------	----------

*Continued on following page.*

## Organizational Responsibility

**Responsible Mission Directorate:**

Space Technology Mission Directorate (STMD)

**Lead Center / Facility:**

Glenn Research Center (GRC)

**Responsible Program:**

Game Changing Development

## Project Management

**Program Director:**

Mary J Werkheiser

**Program Manager:**

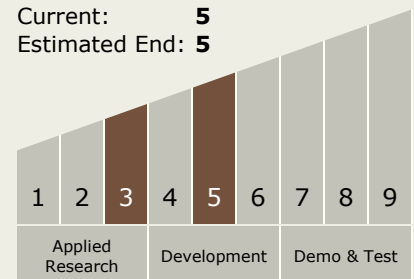
Gary F Meyering

**Principal Investigator:**

Frederick W Elliott

## Technology Maturity (TRL)

Start: 3  
Current: 5  
Estimated End: 5



## Extreme Environment Solar Power (EESP)

Completed Technology Project (2015 - 2020)

Primary U.S. Work Locations (*cont.*)

New Jersey	New Mexico
Ohio	Texas

## Project Transitions

**October 2015:** Project Start**April 2020:** Closed out

**Closeout Summary:** The EESP project developed Inverted Metamorphic Multi-junction (IMM4) solar cells that exceeded the technical performance (KPP) goals and could be integrated into planar or concentrator array configurations. The substantial improvements on concentrator technology may lead to Jupiter bound spacecraft being better able to support their electrical loads with a solar array (potentially increasing science capability of a solar-powered spacecraft).

## Images

**Extreme Environment Solar Power (EESP).jpg**

Technicians test the deployment of a massive solar array that will power future NASA spacecraft. (<https://techport.nasa.gov/image/143239>)

## Project Website:

<https://www.nasa.gov/directorates/spacetech/home/index.html>

## Technology Areas

## Primary:

- TX03 Aerospace Power and Energy Storage
  - └ TX03.1 Power Generation and Energy Conversion
    - └ TX03.1.1 Photovoltaic

## Target Destinations

The Moon, Others Inside the Solar System